



# **CLEAN DIESEL DEMONSTRATION PROGRAM**

*Diesel Emissions Control  
Retrofit Workshop  
March 23, 2000*

# OUTLINE

- ❑ Program Objectives
- ❑ Partners and Roles
- ❑ Project Workplan
  - ✓ Field Demonstration
  - ✓ Emissions Testing
  - ✓ Fuels Matrix Testing
- ❑ Technology Issues
- ❑ Current Results

# PROJECT OBJECTIVES

- ❑ Evaluate the particulate emissions reductions available using JM's CRT<sup>™</sup> technology in conjunction with reduced sulfur diesel fuel
- ❑ Evaluate the applicability of the technology to both new 4-stroke and older 2-stroke diesel engines
- ❑ Evaluate the maintainability and durability of CRTs in rigorous New York City bus service
- ❑ Evaluate fuel parameters that can enhance future commercial success

# TECHNOLOGY

- ❑ Continuously Regenerating Technology
  - ✓ Oxidation catalyst and wall-flow ceramic filter
  - ✓ Packaged to replicate OEM muffler dimensions
  - ✓ No moving parts
  - ✓ No external energy requirements
- ❑ Reduced Sulfur Diesel Fuel
  - ✓ Base specification similar to #1 Diesel
  - ✓ Sulfur level of 30 ppm (350 - 500 ppm standard)
  - ✓ Lubricity enhancement

# PROJECT PARTNERS

- ❑ Johnson Matthey - *CRT technology*
- ❑ Corning - *ceramic filters*
- ❑ Equilon - *reduced sulfur diesel fuel*
- ❑ Environment Canada - *emissions testing*
- ❑ New York State Department of Environmental Conservation - *program development/testing*
- ❑ RAD Energy - *fuel logistics*
- ❑ MTA New York City Transit - *bus operations*

# Budget

CRT Purchase/Installation	\$497,055
Reduced Sulfur Fuel Purchase	\$761,364
Emissions Testing	\$228,678
Fuels Matrix Testing	\$311,826
Technical Support	\$170,470
Project Management	<u>\$108,280</u>
<i>Total</i>	\$2,077,673

# PROJECT WORKPLAN

- ❑ Fleet Demonstration
  - ✓ In service test of 50 buses for 1 year
- ❑ Emissions Testing
  - ✓ Baseline testing
  - ✓ Durability testing
- ❑ Fuels Matrix Evaluation
  - ✓ Fuel additives
  - ✓ Sulfur sensitivity
  - ✓ Aromatics content

# FLEET DEMONSTRATION

- ❑ 50 buses equipped with CRT systems in revenue service in Manhattan for one year
  - ✓ 25 1999 buses with Detroit Diesel Series 50 engines
  - ✓ 25 1993 buses with Detroit Diesel 6V92 DDEC engines
- ❑ One entire depot (140 buses) to operate on reduced sulfur fuel for one year (1.2 mill gallons)
- ❑ 4 buses equipped with continuous data loggers; all others will be monitored monthly for changes in engine back-pressure, and fuel economy



# EMISSIONS TESTING

- ❑ 4 buses tested at the beginning of the program
  - ✓ 2 w/ DDC Series 50 engine; 2 w/ DDC 6V92 engine
- ❑ Each bus tested with OEM muffler/standard fuel, with OEM muffler/30 ppm sulfur fuel, and with CRT system/30 ppm sulfur fuel
- ❑ Test on chassis dynamometer using CBD and New York bus cycles
- ❑ Collect info on criteria emissions (CO, HC, NO<sub>x</sub>, PM), plus particle size and toxicity
- ❑ Re-test each bus after 9 - 12 months in service

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# CHASSIS DYNAMOMETER

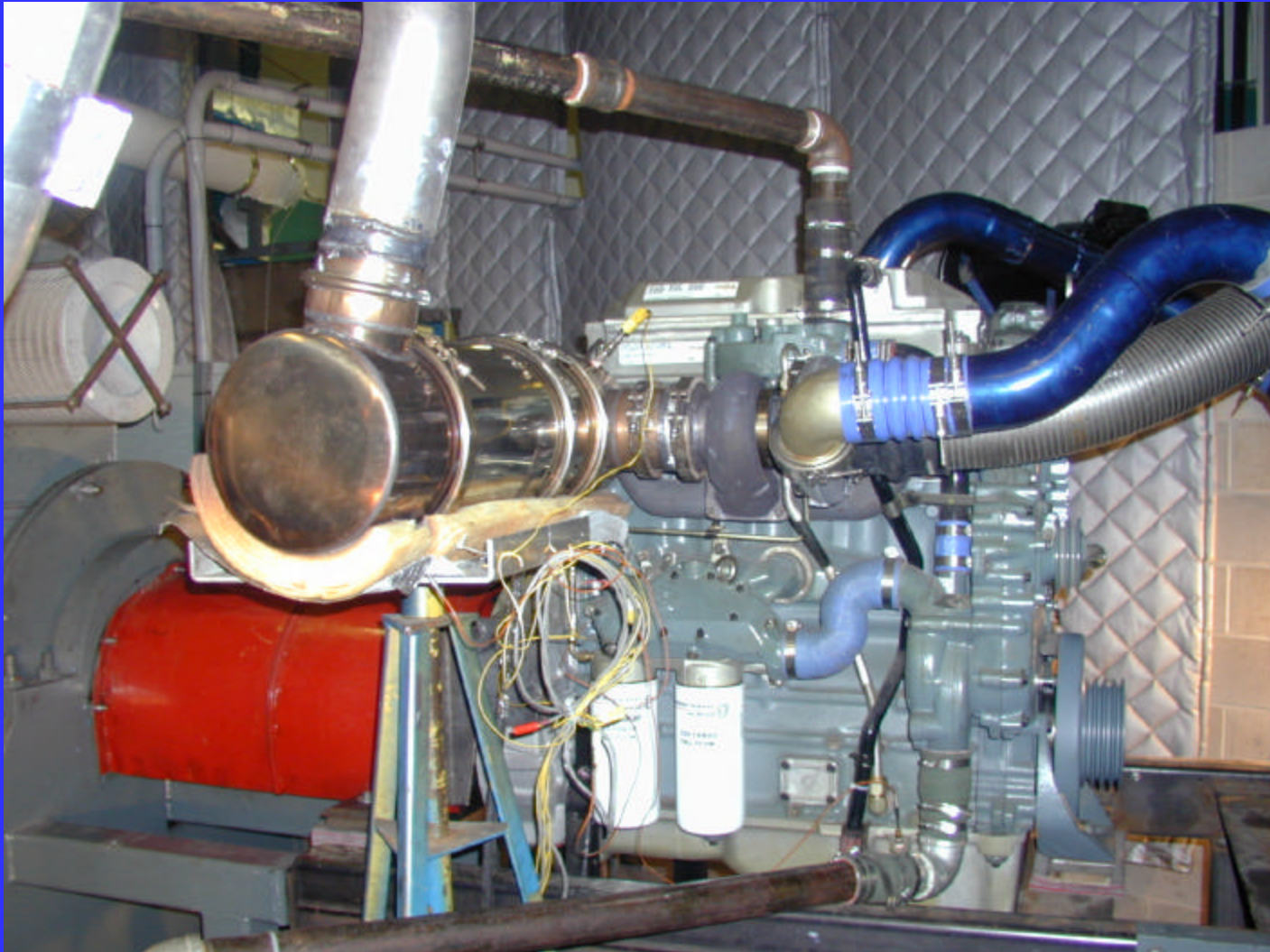


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# FUELS MATRIX TESTING

- ❑ Test various fuel formulations on engine dyno using a 1996 DDC Series 50 Urban bus engine
- ❑ Fuel formulations will vary by sulfur content, aromatics content, proprietary additive packages
- ❑ If a new formulations is judged superior to reference reduced sulfur fuel, perform limited field testing
  - ✓ Equip 2 Series 50 OC Transpo Buses with CRTs and data loggers, operate for 3 months
  - ✓ Chassis dyno emissions test

# ENGINE TEST CELL



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# FUEL LOGISTICS

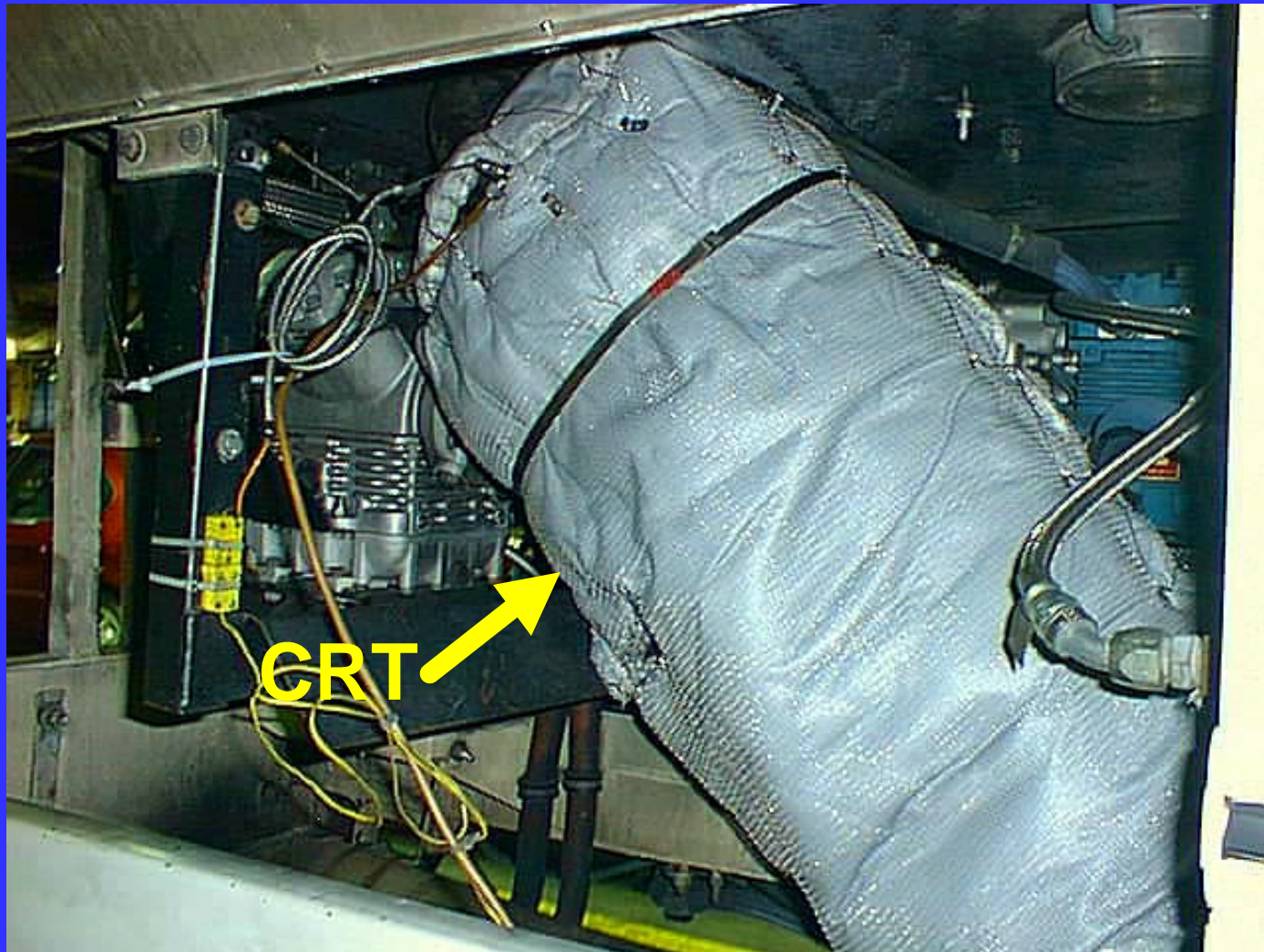
- ❑ Purchase and use of non-commercial fuel requires special handling
  - ✓ Segregated bulk transportation (barge)
  - ✓ Segregated bulk storage in NYC region
  - ✓ Segregated delivery to depot
- ❑ Project purchased all 1.2 million gallons in a single batch to ensure product consistency
- ❑ Testing fuel came from same batch as fuel used in fleet demonstration
- ❑ Handling is largest share of incremental cost



# CURRENT RESULTS 6V92

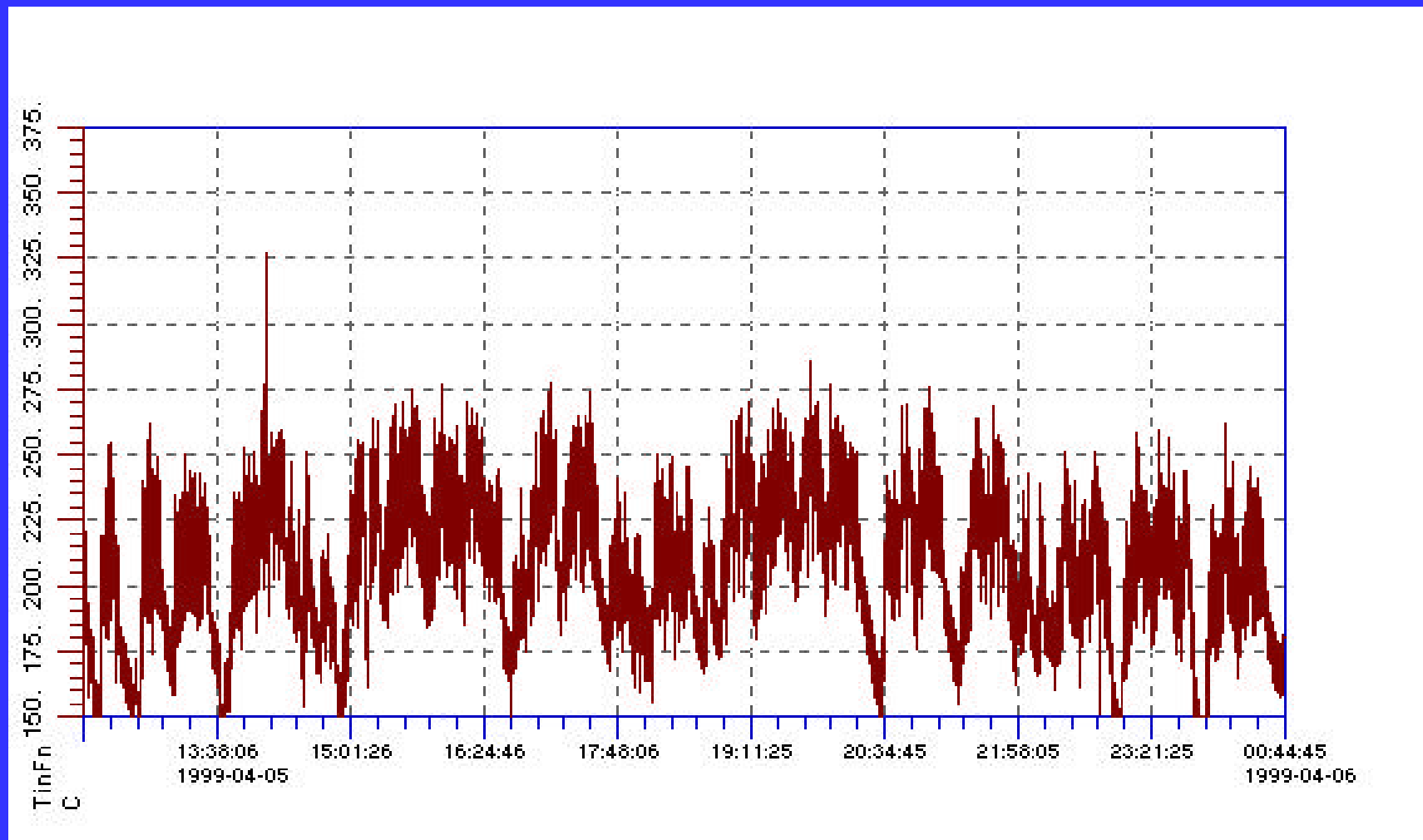
- ❑ Prototype CRT system successfully demonstrated in service for 2 weeks
- ❑ In-service exhaust temperatures at lower margin of acceptable - especially with low ambient temperatures
- ❑ Improved insulation of exhaust path has helped
- ❑ We are investigating ways to temper intake air temperature by routing from engine compartment
- ❑ Fleet demonstration to kick-off later this spring

# CRT INSTALLATION 6V92 Engine



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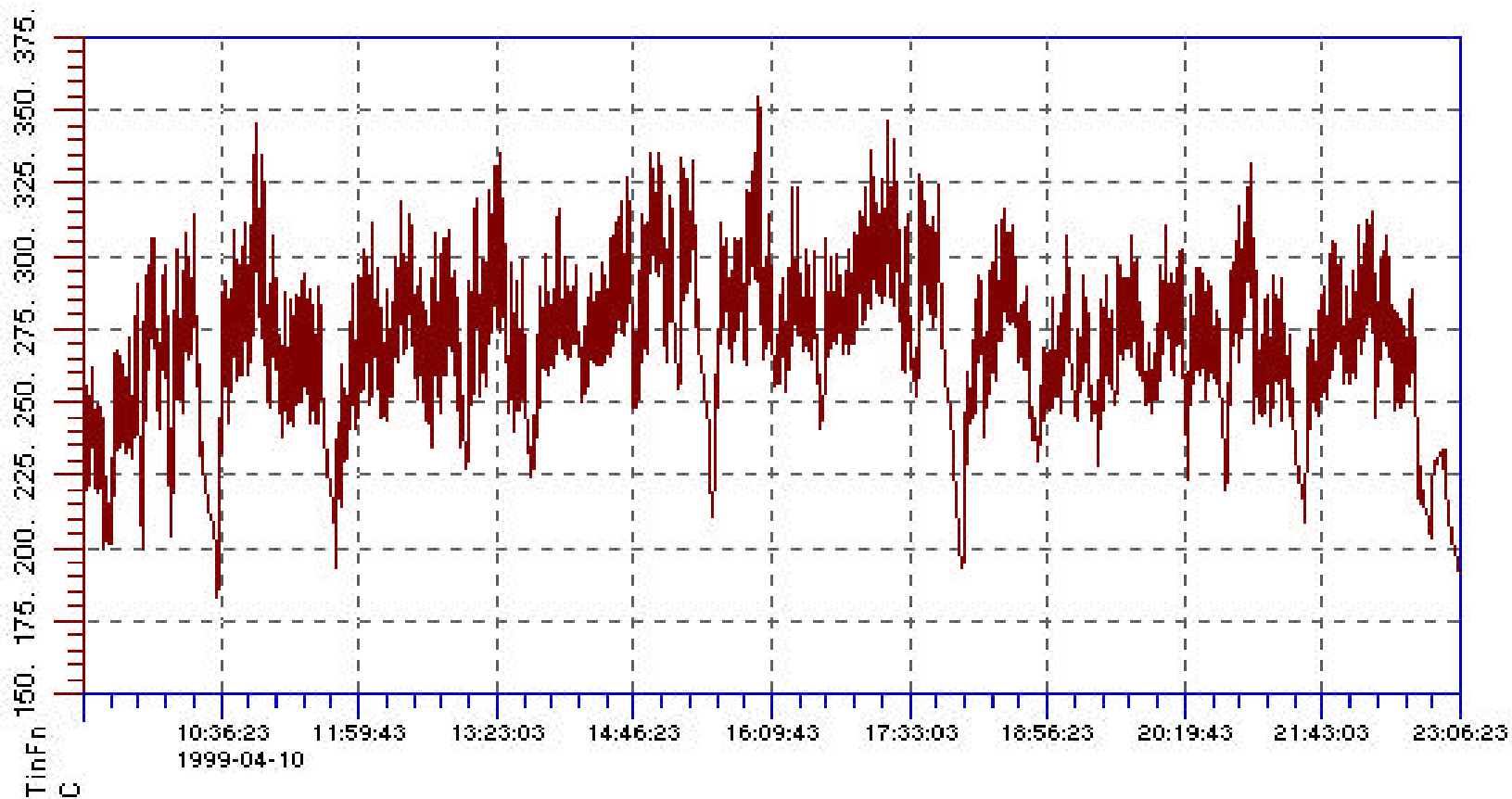
# 6V92 EXHAUST TEMPERATURE (without insulation)



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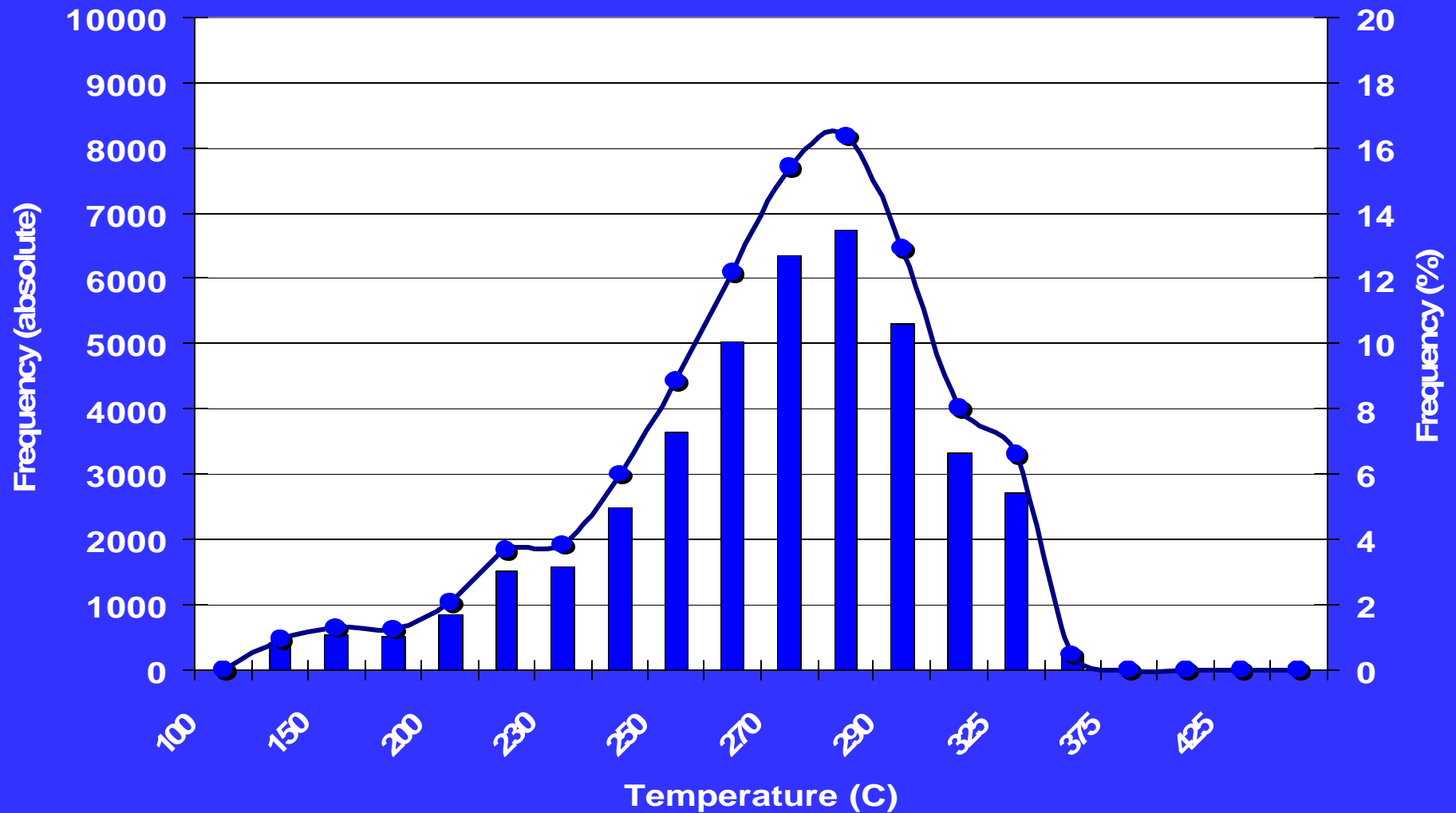


# 6V92 EXHAUST TEMPERATURE (with Insulation)



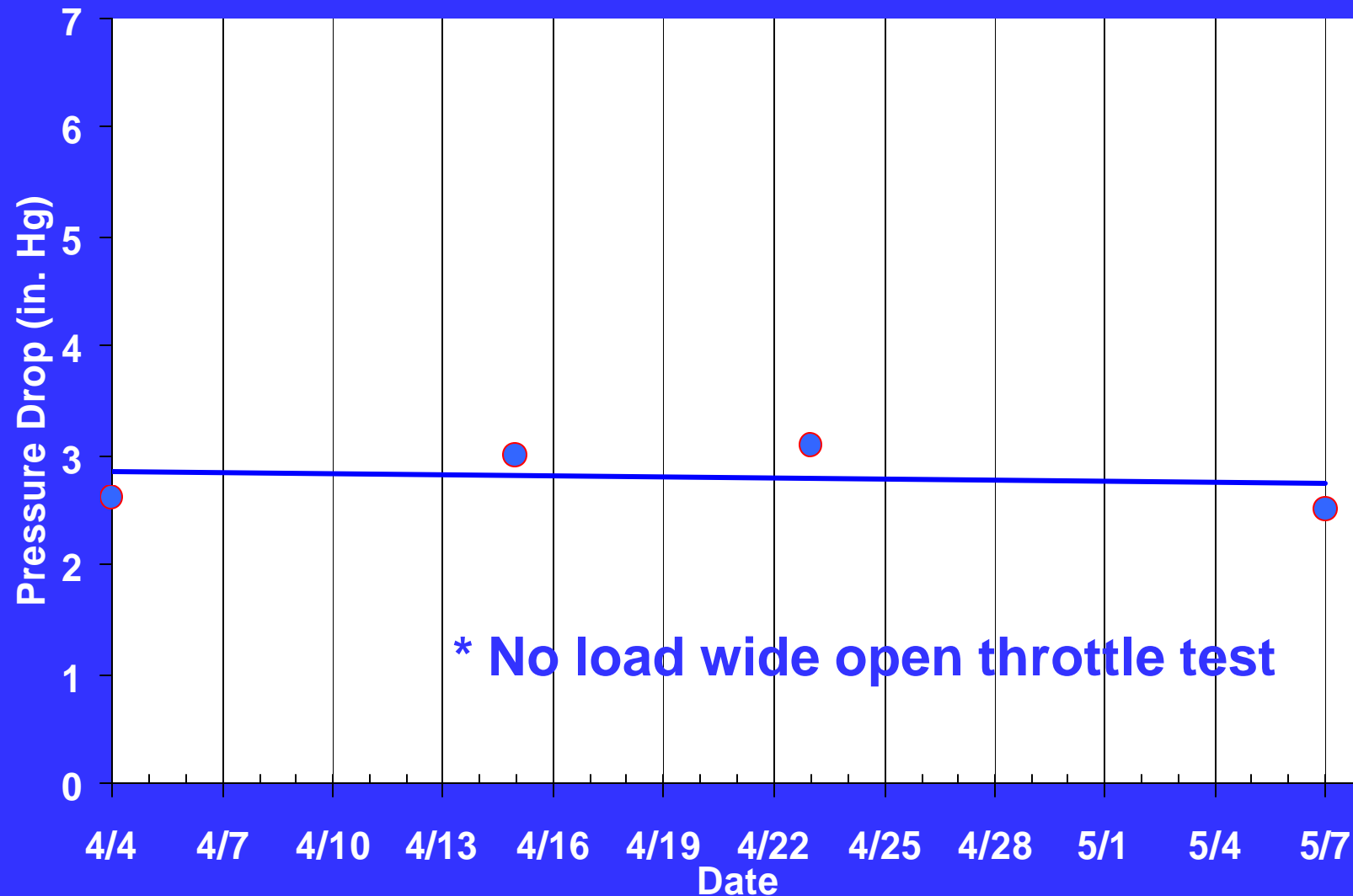
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# 6V92 EXHAUST TEMPERATURE



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# 6V92 BACK PRESSURE\*

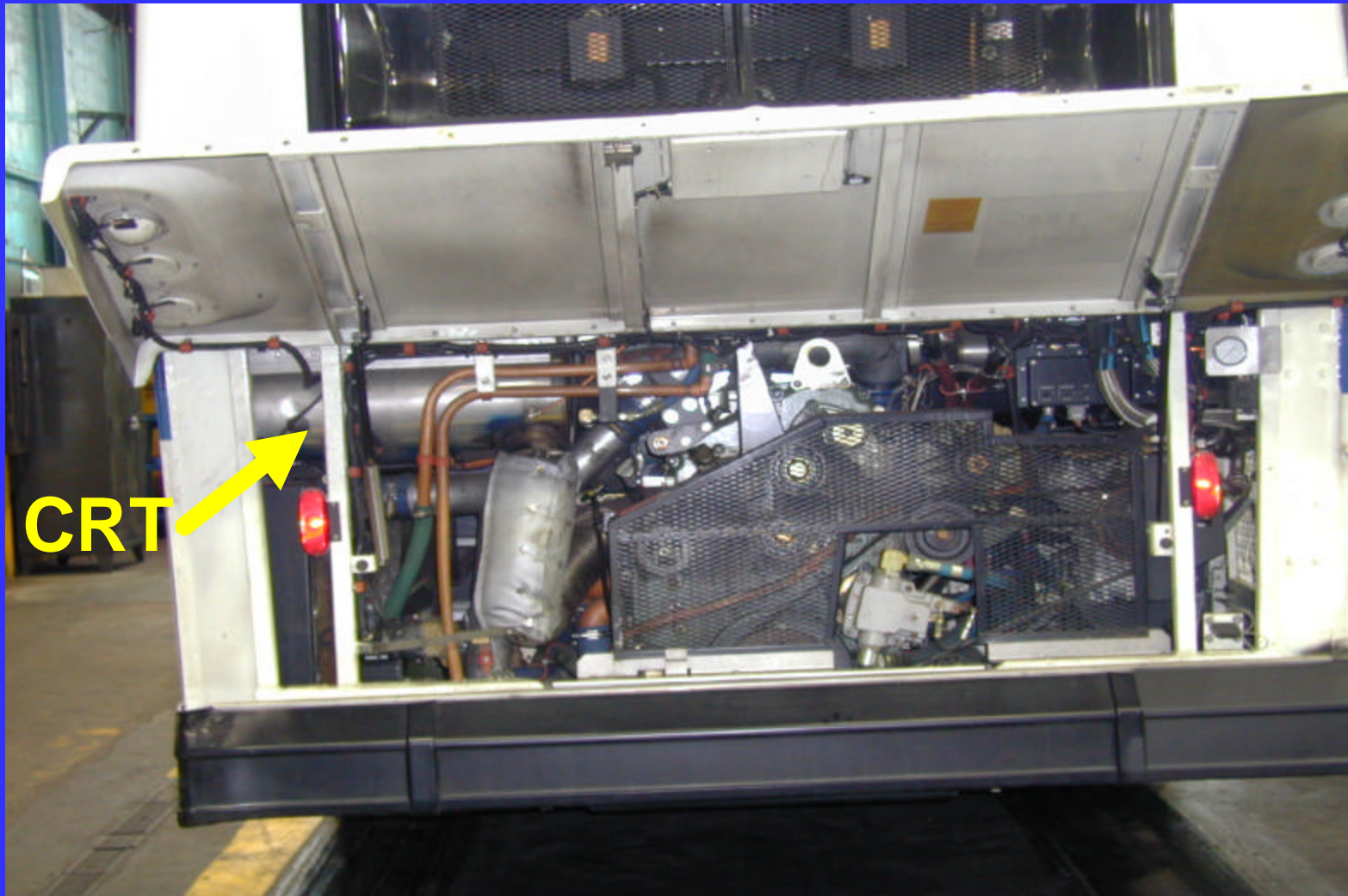


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# CURRENT RESULTS S50

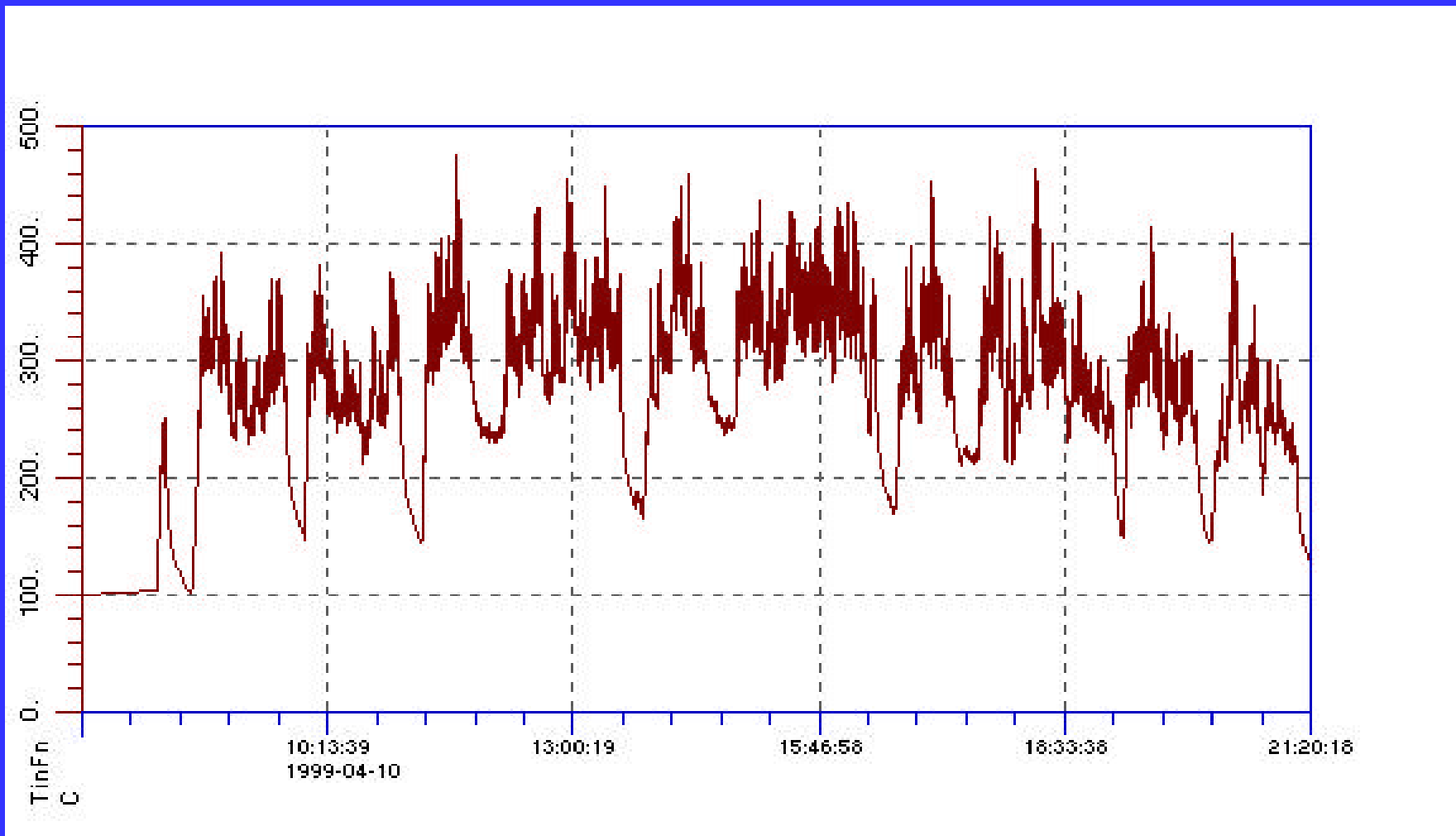
- ❑ Prototype testing showed in-service exhaust temperatures to be very acceptable
- ❑ Fleet demonstration kicked off Feb. 1, 2000
- ❑ Currently have 22 CRT buses in service
- ❑ CRT buses have logged 37,298 miles
- ❑ No CRT-related road calls to date; MBDF of CRT fleet is equivalent to non-CRT buses
- ❑ No back-pressure problems to date

# CRT INSTALLATION S50 Engine



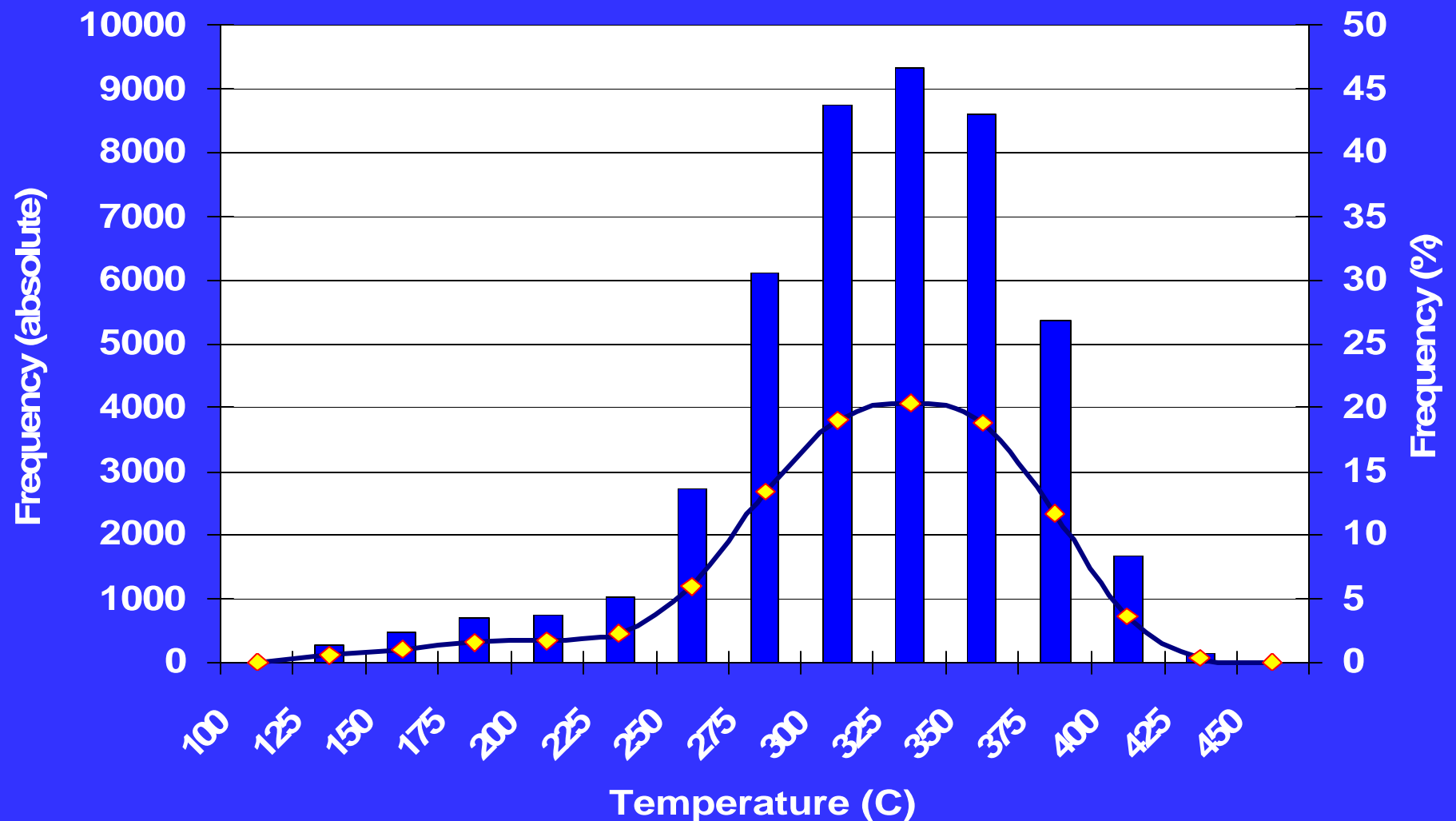
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# S50 EXHAUST TEMPERATURE



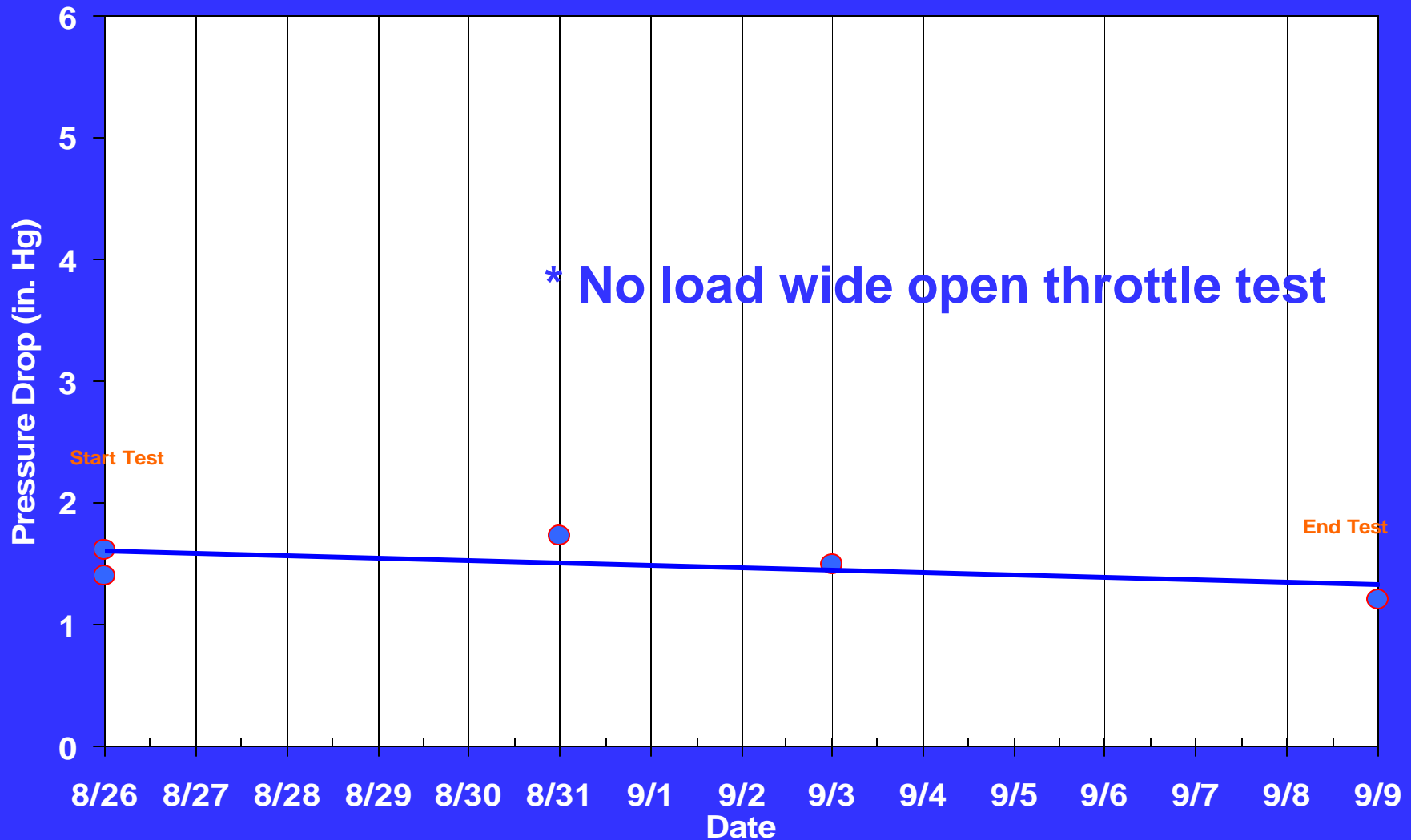
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# S50 EXHAUST TEMPERATURE



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# S50 BACK PRESSURE\*



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# FUTURE SCHEDULE

- ❑ Complete baseline emissions testing by 4/14/00
- ❑ Begin 6V92 Fleet Demonstration when the weather warms up (3/27/00)
- ❑ Conduct Fuels Matrix Testing beginning 4/24/00
- ❑ Complete Fleet demonstration when the 30 ppm fuel runs out (1/16/01)
- ❑ Conduct durability emissions testing (1/16/01)